

**CLAIMS:**

1. A method for reducing noise in a discrete pixel image, the method comprising the steps of:

(a) shrinking an initial image by a given factor to produce a shrunken image;

(b) processing the shrunken image to reduce image noise by selectively processing one or more selected regions of the shrunken image and differentially processing one or more non-selected regions of the shrunken image such that a processed image results;

(c) expanding the processed image by the given factor to produce an expanded image; and

(d) blending one or more selected regions of the expanded image with one or more corresponding regions of the initial image.

2. The method of claim 1, wherein the step of shrinking is accomplished by a sub-sampling technique.

3. The method of claim 2, wherein the sub-sampling technique is pixel averaging.

4. The method of claim 3, wherein the pixel averaging is non-overlapping.

5. The method of claim 1, wherein the step of shrinking is accomplished by use of a boxcar filter.

6. The method of claim 1, wherein the given factor is multi-dimensional and each dimensional factor is greater than or equal to one.

7. The method of claim 1, wherein the selected regions are determined based upon a scaled threshold value.

8. The method of claim 7, wherein the scaled threshold value is computed based upon an initial threshold value and a scaling factor input by a user.

5 9. The method of claim 1, wherein in step (b) the selected regions comprise pixels having values below a first threshold value but above a second, lower threshold value, and positioned adjacent to a pixel having a value at or above the first threshold value.

10 10. The method of claim 9, wherein the first threshold is based upon a scaling factor selected by a user.

15 11. The method of claim 1, wherein in step (b) the processing of selected regions comprises smoothing pixels based upon a dominant orientation and an orientation orthogonal to the dominant orientation.

12. The method of claim 1, comprising the further step of smoothing image data contained in the shrunk image prior to identifying the selected regions.

20 13. The method of claim 1, wherein in step (b) the processing of selected regions comprises directional sharpening of pixels in the selected region having a value above a desired lower limit value.

25 14. The method of claim 13, wherein the process of sharpening comprises comparing a sharpened pixel in the selected region to one or more thresholds and limiting the value of the sharpened pixel to the threshold value where the sharpened pixel value exceeds the threshold value.

30 15. The method of claim 1, wherein the step of expanding is accomplished using an interpolation technique.

16. The method of claim 15, wherein the interpolation technique is cubic interpolation.

17. The method of claim 1, wherein in step (d) the blending of one or more selected regions comprises one region comprising the one or more selected regions of step (b) and one region comprising the one or more non-selected regions of step (b).

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18. The method of claim 1, wherein in step (d) the blending of one or more selected regions with the one or more corresponding regions may occur in different proportions for different selected regions.

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19. A method for reducing noise in a discrete pixel image, the method comprising the steps of:

(a) sub-sampling an initial image containing image data representative of pixels of a reconstructed image such that a shrunk image results and where the initial image is shrunk by a factor greater than one;

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(b) identifying structural features from image data represented in the shrunk image;

(c) smoothing the structural features to enhance the dominant orientation of the structural features;

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(d) smoothing non-structural region to enhance the homogenization of the non-structural region;

(e) sharpening the structural features to enhance the dominant orientation associated with the structural features;

(f) expanding the shrunk image by the factor such that an expanded image results which has the same dimensions as the initial image; and

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(g) blending a fraction of the expanded image with image data from the first initial image.

20. The method of claim 19, wherein the step of sub-sampling is accomplished by pixel averaging.

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21. The method of claim 20, wherein the pixel averaging is non-overlapping.

22. The method of claim 19, wherein the step of sub-sampling is accomplished by use of a boxcar filter.

5 23. The method of claim 19, wherein the factor is multi-dimensional and each dimensional factor is greater than or equal to one.

24. The method of claim 19, wherein the structural features are determined based upon a scaled threshold value.

10 25. The method of claim 24, wherein the scaled threshold value is computed based upon an initial threshold value and a scaling factor input by a user.

15 26. The method of claim 19, wherein in step (b) the structural features comprise pixels having values below a first threshold value but above a second, lower threshold value, and positioned adjacent to a pixel having a value at or above the first threshold value.

20 27. The method of claim 26, wherein the first threshold is based upon a scaling factor selected by a user.

25 28. The method of claim 19, wherein in step (c) the smoothing of structural features to enhance their dominant orientation includes smoothing pixels based upon a dominant orientation and an orientation orthogonal to the dominant orientation.

29. The method of claim 19, comprising the further step of smoothing image data contained in the shrunken image prior to identifying the structural features.

30 30. The method of claim 19, wherein in step (e) the sharpening of structural features to enhance their dominant orientation comprises the sharpening of pixels in the structural features having a value above a desired lower limit value.

31. The method of claim 30, wherein the process of sharpening comprises comparing a sharpened pixel in the structural features to one or more thresholds and limiting the value of the sharpened pixel to the threshold value where the sharpened pixel value exceeds the threshold value.

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32. The method of claim 19, wherein the step of expanding is accomplished using an interpolation technique.

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33. The method of claim 32, wherein the interpolation technique is cubic interpolation.

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34. The method of claim 19, wherein in step (g) the fraction comprises two or more portions such that the two or more portions are blended in different proportions.

35. The method of claim 34, wherein one portion comprises the structural features and one portion comprises the non-structural region.

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36. A system for reducing noise in a discrete pixel image, the system comprising:

an output device for producing a reconstructed image based upon processed image data; and

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a signal processing circuit configured to provide processed image data by sub-sampling image data representative of pixels of an initial image to produce a shrunk image, identifying one or more selected regions of the shrunk image using one or more selection criteria, processing the selected regions and the non-selected regions in different manners to create a processed image, expanding the processed image to the same dimensions as the initial image, and blending a fraction of the expanded image data with the initial image data.

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37. The system of claim 36, further comprising an image data acquisition system for producing image data signals processed by the signal processing circuit.

38. The system of claim 37, wherein the image data acquisition system comprises a medical imaging scanner.

5 39. The system of claim 36, wherein the selected region is determined based upon a scaled threshold value.

40. The system of claim 39, wherein the scaled threshold value is computed based upon an initial threshold value and a scaling factor input by a user.

10 41. The system of claim 36, wherein the selected region comprises pixels having values below a first threshold value but above a second, lower threshold value, and positioned adjacent to a pixel having a value at or above the first threshold value.

15 42. The system of claim 36, wherein the sub-sampling is accomplished by pixel averaging.

43. The system of claim 42, wherein the pixel averaging is non-overlapping.

20 44. The system of claim 36, wherein the step of sub-sampling is accomplished by use of a boxcar filter.

25 45. The system of claim 36, wherein the sub-sampling factor by which the initial image is shrunk is multi-dimensional and each dimensional factor is greater than or equal to one.

46. The system of claim 36, wherein the step of expanding is accomplished using an interpolation technique.

30 47. The system of claim 46, wherein the interpolation technique is cubic interpolation.

48. The system of claim 36, wherein the fraction of the expanded image data comprises two or more portions such that the two or more portions are blended in different proportions.

5 49. The method of claim 48, wherein one portion comprises the selected regions and one portion comprises the non-selected regions.

50. A system for reducing noise in a discrete pixel image, the system comprising:

10 an output device for producing a reconstructed image based upon processed image data; and

a signal processing circuit configured to provide processed image data by sub-sampling image data representative of pixels of an initial image to produce a shrunk image, smoothing image data representative of pixels of the shrunk image, identifying one or more structural features from the smoothed image data, orientation smoothing the structural features, homogenization smoothing non-structural regions, orientation sharpening the structural features, expanding the shrunk image to the same dimensions as the initial image to form an expanded image, and blending of the initial image data into the expanded image data.

20 51. The system of claim 50, further comprising an image data acquisition system for producing image data signals processed by the signal processing circuit.

25 52. The system of claim 51, wherein the image data acquisition system comprises a medical imaging scanner.

53. The system of claim 50, wherein the structural features are determined based upon a scaled threshold value.

30 54. The system of claim 53, wherein the scaled threshold value is computed based upon an initial threshold value and a scaling factor input by a user.

55. The system of claim 50, wherein the structural features include pixels having values below a first threshold value but above a second, lower threshold value, and positioned adjacent to a pixel having a value at or above the first threshold value.

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56. The system of claim 50, wherein the orientation smoothing is based upon a dominant orientation and an orientation orthogonal to the dominant orientation.

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57. The system of claim 50, wherein orientation smoothing is performed based upon a predetermined relationship between a characteristic of each structural pixel in the dominant orientation and in the orthogonal orientation.

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58. The system of claim 56, wherein the characteristic is a number of counts of orientations within a neighborhood of each structural pixel.

59. The system of claim 50, wherein the sharpening is performed only for structural pixels having a value above a desired lower limit value.

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60. The system of claim 50, wherein the sub-sampling is accomplished by pixel averaging.

61. The system of claim 60, wherein the pixel averaging is non-overlapping.

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62. The system of claim 50, wherein the step of sub-sampling is accomplished by use of a boxcar filter.

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63. The system of claim 50, wherein the sub-sampling factor by which the initial image is shrunk is multi-dimensional and each dimensional factor is greater than or equal to one.



64. The system of claim 50, wherein the step of expanding is accomplished using an interpolation technique.

5 65. The system of claim 64, wherein the interpolation technique is cubic interpolation.

66. The method of claim 50, wherein the blended image data comprises two or more portions such that the two or more portions are blended in different proportions.

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67. The method of claim 66, wherein one portion comprises the structural features and one portion comprises the non-structural region.